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ABSTRACT

This is one of eighteen sets of individualized mathematics problems developed by the Oregon Vo-Tech Math Project. Each of these problem packages is organized around a mathematical topic and contains problems related to diverse vocations. Solutions are provided for all problems. This package contains problems related to measurement of area which arise in six vocational situations (construction, diesel mechanics, electronics, forestry, forest products, and drafting). (SD)

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# I L S INDIVIDUALIZED LEARNING SYSTEMS

## Individualized Math Problems in

# Area

## Oregon Vo-Tech Mathematics Problem Sets

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SE 020 631

STATE DEPARTMENT
OF EDUCATION
942 Lancaster Drive, NE
Salem, Oregon 97310
JESSE FASOLD
Superintendent of
Public Instruction

Project Director:
Dell Swearingen
Linn-Benton Community College

Ex-Director:
Galen Nielsen
Linn-Benton Community College

Writers:
John Anderson
Southwestern Oregon College

Ted Boyll
Treasure Valley Community College

Richard Claudson
Treasure Valley Community College

Bud Cook
Lane Community College

Kay Elling
Chemeketa Community College

Gene Enfield
Sprague High School

Bobby Finnell
Portland Community College

Don Gallagher
Central Oregon Community College

Harold Hauser
Blue Mountain Community College

Al Hendricksen
Marshfield High School

Editor:
Norma Cosler

Consultant:
Jerry Ludlow
State Department of Education

Writers:
Frank Holliday
Rogue Community College

Woody LaSueur
Canby High School

Henry Lind
Portland Community College

Mike Morgan
Linn-Benton Community College

Harrison Platt
Clackamas Community College

Bill Rino
Roseburg High School

Merlin Salter
Chemeketa Community College

Ken Thomason
Umpqua Community College

Frank Weeks
Mt. Hood Community College

Assistant Editors:
Bob Mack
Mike Long

Graphic Artist:
Rose Davis

Typists:
Tina Hale
Shelley Mack

Individualized Learning Systems

# MATHEMATICS

**Area**

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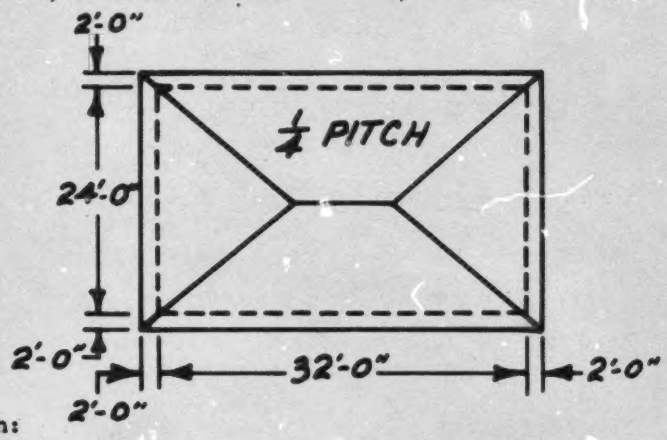
A. Problems with Solutions

1. To find the roof sheathing needed for the hip roof in the sketch, find the area to be covered, including overhang, and add the correct percentage from the following table.
Note: Area = (length)(width)

| | | | |
|---|---|---|---|
| 1/4 Pitch | 12% | 1/2 Pitch | 42% |
| 1/3 Pitch | 20% | 5/8 Pitch | 60% |
| 3/8 Pitch | 25% | 3/4 Pitch | 80% |




Solution:

Length: 32' + 4' overhang = 36 ft

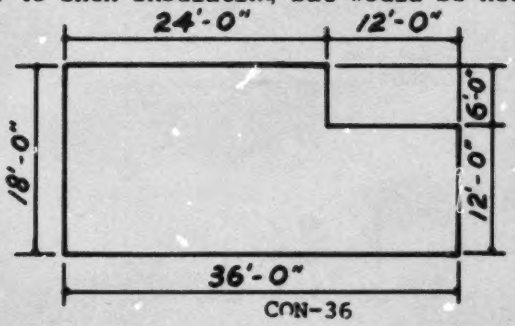
Width: 24' + 4' overhang = 28 ft

Area to cover: (28')(36') = 1,008 sq ft

Sheathing needed: (1,008)(12%) + 1,008 = 1,129 sq ft

2. Bat insulating material is figured by the square foot and comes in 4 inch thickness, 8 inch x 15 inch, and 16 inch x 48 inch in size. To determine amount needed, determine square footage to be insulated, and deduct for all openings.

The walls of the accompanying floor plan are 8 feet high, and there are 125 square feet of openings. How many pieces of 16 inch x 48 inch insulating bat would be needed?




CON-36

A. Problems with Solutions (continued)

2. (continued)

Solution:

| | | |
|---|---|---|
| Wall area: | 8' x 18' = | 144 sq ft |
| | 8' x 24' = | 192 sq ft |
| | 8' x 6' = | 48 sq ft |
| | 8' x 12' = | 96 sq ft |
| | 8' x 12' = | 96 sq ft |
| | 8' x 36' = | 288 sq ft |
| | | 864 sq ft |

Footage need = footage to be insulated - wall openings

= 864 sq ft - 125 sq ft
= 739 sq ft

Area of one section of insulating material = (1 1/3')(4')
= 5 1/3 sq ft

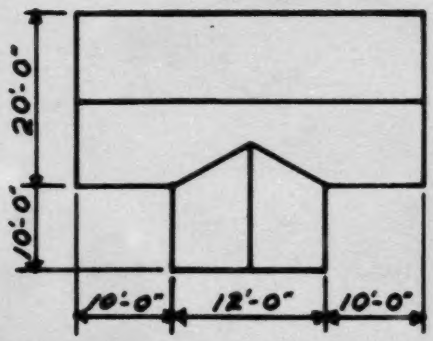
Therefore, the number of bats needed is $\frac{739 \text{ sq ft}}{5\ 1/3 \text{ sq ft/bat}} = 138.56$

or 139 bats

3. Find the sheathing needed for the gable and valley roof if the eave overhang is 18", the gable and projection is 12" and the pitch is 1/2.

To find the board feet of roof sheathing (laid tight) needed for any given pitched roof, use the approximate percentage of allowances which have been established for various pitched roofs, and add this to the square area to be covered. The percentages are:

| | |
|---|---|
| 1/4 pitch 12% | 1/2 pitch 42% |
| 1/3 pitch 20% | 5/8 pitch 60% |
| 3/8 pitch 25% | 3/4 pitch 80% |



A. Problems with Solutions (continued)

3. (continued)

Solution:

Area of Main Roof:

length = 10' + 12' + 10' + (1' projection)(2 ends)
= 32' + 2'
length = 34'

width = 20' + (1 1/2' overhang)(2 ends)
= 20' + 3'
width = 23'

Area =(34')(23') = 782 sq ft

Area of Small Roof:

length = 12' + (1 1/2' overhang)(2 ends)
= 12' + 3'
length = 15'

width = 10' + 1' projection
= 11'

Area = (15')(11') = 165 sq ft

Total area = 782 sq ft + 165 sq ft
= 947 sq ft

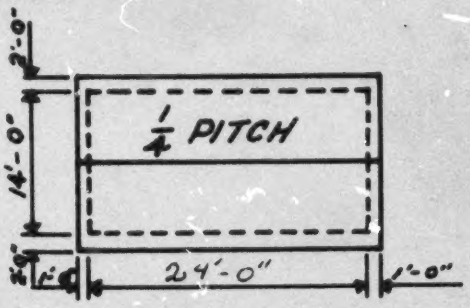
Area of sheathing = 947 sq ft + (42%)(947 sq ft)
= 947 sq ft + 398 sq ft
= 1,345 sq ft

B. Problems without Solutions

4. A room is 15 feet wide and 21 feet long. How many 9" x 9" tile would be needed to cover the floor of this room?

B. Problems without Solutions (continued)

5. To find the square feet of shingle strips for a roof, consider just the square area to be covered plus overhang. No percentage allowance is added. Find the board feet of shingle strips needed for the roof shown in the sketch.
Note: Area = (Length)(Width)




6. Determine the number of 4' x 8' sheets of plywood needed to build a rectangular bin 6 feet long, 4 feet wide, and 3 feet high. Do not use any pieces too small to cover a surface. Determine the amount of waste.

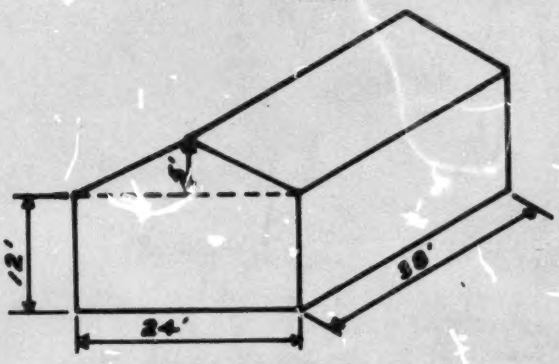
Level 1

7. How many squares of roofing would be required to cover a roof if one side measures 24' x 36' (both sides are the same)?
Note: 1 square of roofing = 100 sq ft.

B. Problems without Solutions (continued)

8. Figure the cost to carpet a 13' x 19' room if the pad costs $1.75 per square yard, the carpet is $7.95 per square yard, and installation is $1.05 per square yard.

9. How many squares of 28 gauge galvanized siding would be required for the shed as shown below? (Assume no doors or windows at this point and that a different material is to be used for the roof.)
Note: 100 sq ft = 1 square. Area of a triangle = (1/2 base)(height)




Prob. # 9

B. Problems without Solutions (continued)

10. The standard common brick is 8" x 2 1/4" x 3 3/4". The number of bricks needed for each square foot of wall surface depends on the thickness of the wall.

    8" wall requires 15 bricks per square foot.
    12" wall requires 22 1/2 bricks per square foot.
    16" wall requires 30 bricks per square foot.

    Each additional 4" in wall thickness requires 7 1/2 additional bricks for each square foot in the wall face. Find the number of bricks needed for a wall 24' 6" long, 7' 8" high, and 24" thick.

11. The number of bricks needed to veneer a wall depends on the number of openings, belt courses, etc. that must be deducted for, and the thickness of mortar joints used. A 1/2" mortar joint requires 6 bricks per square foot, and for each 1/8" difference of mortar joint, the number of bricks varies by 1/2 brick. How many bricks are needed to veneer a wall 3' 6" high and 12' 8" long using a 3/8" mortar joint?

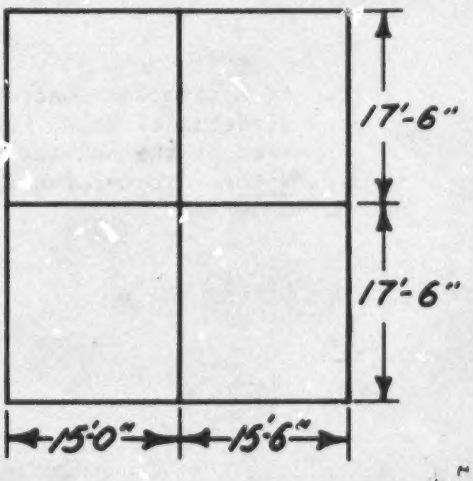
B. Problems without Solutions (continued)

12. The standard common brick is 8" x 2 1/4" x 3 3/4". The number needed for each square foot of wall surface depends on the thickness of the wall.

    8" wall requires 15 bricks per square foot.
    12" wall requires 22 1/2 bricks per square foot.
    16" wall requires 30 bricks per square foot.

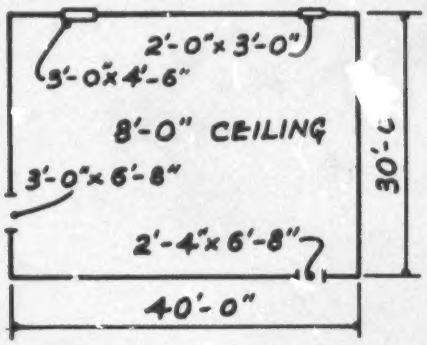
    Each additional 4" in wall thickness requires 7 1/2 additional bricks for each square foot in the wall face. How many bricks are needed for a wall 30' long, 8' high, and 12" in thickness?

13. How many square yards of interior wall is there for the floor plan shown if the wall heighth is 8'? Deduct 7% for openings.



B. Problems without Solutions (continued)

14. Determine the number of square yards of wall area to be plastered. (A good role of thumb is to deduct 7% from total area for openings.)




15. If a circular concrete tank is eleven feet high, has an inside diameter of 7' 6", and the wall is 8" thick, find the surface area of the outside of the tank.
Note: Circumference of a circle = $\pi$ (diameter).

Complete Solutions to B Problems

4. $15' = (15')(12''/\cancel{ft}) = 180''$

It would take $\frac{180 \cancel{\text{inches}}}{9 \cancel{\text{inches}}/\text{tile}} = 20$ tile to go the width of the room

$21' = (21')(12''/\cancel{ft}) = 252''$

It would take $\frac{252 \cancel{\text{inches}}}{9 \cancel{\text{inches}}/\text{tile}} = 28$ tile to go the length of the room

The room is 20 tiles x 28 tiles, that is, the total number of tile equals $(20)(28) = 560$ tile.

5. Length = 24' + 1' + 1' = 26 feet

Width = 14' + 2' + 2' = 18 feet

Area = (26')(18') = 468 sq ft

6. The bin will require one sheet for the bottom, one for the two ends, and one for each of the other two sides.

The total surface area of the plywood is:

Surface area = 4 sheets @ (4')(8')
= 4 sheets @ 32 sq ft
= 128 sq ft

Area of side of bin = (2 sides)(3')(6') = 2 sides @ 18 sq ft = 36 sq ft
" " ends " " = (2 sides)(3')(4') = 2 sides @ 12 sq ft = 24 sq ft
" " bottom " = (1 side) (4')(6') = 1 side @ 24 sq ft = 24 sq ft

Total area of bin = 36 sq ft + 24 sq ft + 24 sq ft
= 84 sq ft

Waste = Total wood - used wood
= 128 sq ft - 84 sq ft
= 44 sq ft

Level 1

7. Area = (length)(width)

Area of one side = (24')(36')
= 864 sq ft

Complete Solutions to 1 Problems (continued)

7. (continued)

Area of two sides = (2)(864 sq ft)
= 1,728 sq ft

Therefore, since 1 square = 100 sq ft, there would be

$$\frac{1{,}728 \text{ sq ft}}{100 \text{ sq ft/square}} = 17.28 \text{ squares}$$

8. Total area to be carpeted = (13')(19')
= 247 sq ft

Since there are 9 sq ft/sq yd this is $\frac{247 \text{ sq ft}}{9 \text{ sq ft/sq yd}} = 27.44$ sq yd

Total cost = cost of pad + cost of carpet + cost of installation

Cost of pad = ($1.75/sq yd)(27.44 sq yd) = $48.02

Cost of carpet = ($7.95/sq yd)(27.44 sq yd) = $218.15

Cost of installation = ($1.05/sq yd)(27.44 sq yd) = $28.81

Total cost = $48.02 + $218.15 + $28.81
= $294.98

9. Total area = area of sides + area of rectangular portion of ends + area of triangular section of ends

| | | |
|---|---|---|
| Area of sides = (2 sides)(38')(12') | = | 912 sq ft |
| Area of rec part of ends = (2 ends)(24')(12') | = | 576 sq ft |
| Area of tri part of ends = (2 ends) [(1/2)(24')] (5') | = + | 120 sq ft |
| | | 1,608 sq ft |

Converting, $\frac{1{,}608 \text{ sq ft}}{100 \text{ sq ft/square}} = 16.08$ squares

10. First, calculate total area to be bricked

Area = (length)(height)
= (24' 6")(7' 8")
= (24 1/2')(7 2/3')
= 187 5/6 sq ft

Complete Solutions to B Problems (continued)

10. (continued)

Since there are 8 1/2 bricks per additional 4" and there are 24" - 16" = 8" additional, there are (30 + 15) bricks per sq ft or 45 brick/sq ft

(187 5/6 ~~sq ft~~)(45 bricks/~~sq ft~~) = 8,452 1/2 bricks

11. First, calculate the total area to be bricked

Area = (length)(height)
= (12 2/3')(3 1/2')
= 44 1/3 sq ft

Since you use 1/2 brick less for every 1/8" under 1/2", you would use 1/2" - 3/8" = 4/8" - 3/8"
= 1/8"

Then, (1/8") $\frac{1/2 \text{ brick}}{1/8 \text{ brick}}$ = 1/2 brick/sq ft less than for a wall with 1/2" joints = 6 brick/sq ft - 1/2 brick/sq ft = 5 1/2 brick/sq ft

So, the total number of bricks needed is

(44 1/3 ~~sq ft~~)(5 1/2 brick/~~sq ft~~) ≐ 244 bricks

12. First, solve for the total area to be bricked.

The wall is 30' long and 8' high

Area = (length)(height)

So, the area of the face = (30')(8') = 240 sq ft

Since the wall is 12" thick, it requires 22 1/2 bricks per sq ft of face. The total number of bricks needed is:

(240 ~~sq ft~~)(22 1/2 bricks/~~sq ft~~) = 5,400 bricks

Complete Solutions to B Problems (continued)

13. The interior wall is in four sections, each 8' high.

The sections are 15' 0" x 8'
15' 6" x 8'
17' 6" x 8'
17' 6" x 8'

Since area = (length)(height)

Total area = (15')(8') = 120 sq ft
(15 1/2')(8') = 124 sq ft
(17 1/2')(8') = 140 sq ft
(17 1/2')(8') = +140 sq ft
524 sq ft

So, when you deduct 7% for wall openings, you get

524 sq ft - (524 sq ft)(0.07) = 524 sq ft - 35.68 sq ft
= 487.32 sq ft

Converting, $\frac{487.32 \text{ ~~sq ft~~}}{9 \text{ ~~sq ft~~/sq yd}} = 54.15$ sq yd

Level 2

14. Area = (length)(height)

Therefore, total area = (30')(8') = 240 sq ft
(30')(8') = 240 sq ft
(40')(8') = 320 sq ft
(40')(8') = +320 sq ft
1120 sq ft

So, the area to be plastered = 1120 sq ft - (1120 sq ft)(7%)
= 1120 sq ft - 78.40 sq ft
= 1041.60 sq ft

Converting, $\frac{1041.60 \text{ ~~sq ft~~}}{9 \text{ ~~sq ft~~/sq yd}} = 115.73$ sq yds

15. The surface area of a cylinder = (circumference)(height)
Circumference = ($\pi$)(diameter)
Diameter = 7' 6" + 8" + 8"
= 7' 6" + 16"
= 8' 10"
= 8 5/6'
Circumference = ($\pi$)(8 5/6') = 27.75'
Area = (27.75')(11') = 305.25 sq ft

A. Problems with Solutions

1. Determine pressure in pounds per square inch in an engine cylinder if the force acting upon the piston is 75,000 pounds and the diameter of the piston is 14 inches.

   Solution:

   Area of circle is $(\pi)(r^2)$

   Area of piston head is $(3.1416)(7 \text{ in})^2 \approx 153.938$ sq in

   $\frac{75{,}000 \text{ lbs}}{153.9 \text{ sq in}} \approx 487.3$ lbs/sq in

2. If a cylindrical tank is 3 feet 6 inches in diameter and 4 feet 6 inches long, how many gallons will it hold? (1 gal = 231 cu in)

   Solution:

   $V = (\pi)(r^2)(h)$

   $= (3.14)(21 \text{ in})^2 (54 \text{ in}) = 74{,}775.96$ cu in

   1 gallon = 231 cu in, so, $\frac{74{,}775.96 \text{ cu in}}{231 \text{ cu in}} \approx 323.7$ gal

   (nearest tenth)

3. What is the displacement of a V-8 diesel with 5 inches base and 6 inches stroke? (Displacement is total volume of all cylinders.)

   Solution:

   $V = (\pi)(r^2)(h)$

   $= (3.1416)(5/2 \text{ in})^2 (6 \text{ in})$

   $= 117.81$ cu in

   For 8 cylinders (117.81 cu in/~~cylinder~~)(8 ~~cylinders~~) = 942.48 cu in

4. If the displacement of a diesel engine is 942.48 cu in, what is this is liters?

   Solution:

   If no conversion between cu in and liters is available, one may convert cu in to cc first.

A. Problems with Solutions (continued)

4. (continued)

(942.48 ~~cu in~~)(16.387 cc/cu in) = 15,444.420 cc

A rough answer then is 15.444 liters assuming 1 liter = 1,000 cc

B. Problems without Solutions

5. Find the volume of a cylinder whose inside diameter is 2 inches and whose length is 10 inches. ($V = \pi r^2 h$)

6. Find the volume of a cylinder whose inside diameter is 1 1/2 in and whose length is 12 in. ($V = \pi r^2 h$)

For each of the following described engines, find the cubic inch displacement. Bore is the diameter of the cylinder, Stroke is the height of the cylinder when the piston is in down position.

7. Model NHE-195: 6 cylinders; bore and stroke: 5 1/8" by 6".

B. Problems without Solutions (continued)

8. Model NHC-250 has 6 cylinders. Bore and stroke is 5 1/2" by 6".

9. Model V6E-195 has 6 cylinders. Bore and stroke: 5 1/2" by 4 1/8".

10. Model V8E-235 has 8 cylinders. Bore and stroke: 5 1/2" by 4 1/8".

11. Model V6-140 has 6 cylinders. Bore and stroke: 4 5/8" by 3 1/2".

B. Problems without Solutions (continued)

12. Model V8E-170 has 8 cylinders. Bore and stroke: 4 5/8" by 3 1/2".

13. Model JN-130 has 6 cylinders. Bore and stroke: 4 1/8" by 5".

14. Model CF-160 has 6 cylinders. Bore and stroke: 4 7/16" by 5".

Complete Solutions to B Problems

5. $V = \pi r^2 h$

$= (3.14)(1 \text{ in})^2 (10 \text{ in})$

$= 31.4 \text{ cu in}$

6. $V = \pi r^2 h$

$= (3.14)(3/4 \text{ in})^2 (12 \text{ in})$

$= 21.195 \text{ cu in}$

7. Displacement equals volume of one cylinder times the number of cylinders.

$V = (3.14)(2.5625 \text{ in})^2 (6 \text{ in})$

$= 123.71 \text{ cu in/cylinder}$

$(123.71 \text{ cu in/}\cancel{\text{cylinder}})(6 \cancel{\text{cylinder}}) = 742.27 \text{ cu in}$

8. Volume of one cylinder times number of cylinders $= (\pi r^2 h)(6)$

$(3.14)(2.75 \text{ in})^2 (6 \text{ in}) = 142.48 \text{ cu in/cylinder}$

$(142.48 \text{ cu in/}\cancel{\text{cylinder}})(6 \cancel{\text{cylinders}}) = 854.87 \text{ cu in}$

9. Volume of one cylinder times the number of cylinders

$(3.14)(2.75 \text{ in})^2 (4.125 \text{ in}) = 97.95 \text{ cu in/cylinder}$

$(97.95 \text{ cu in/}\cancel{\text{cylinder}})(6 \cancel{\text{cylinders}}) = 587.72 \text{ cu in}$

10. Volume of one cylinder times the number of cylinders

$(3.14)(2.75 \text{ in})^2 (4.125 \text{ in}) = 97.95 \text{ cu in/cylinder}$

$(97.95 \text{ cu in/}\cancel{\text{cylinder}})(8 \cancel{\text{cylinders}}) = 783.60 \text{ cu in}$

Complete Solutions to B Problems

11. Volume of one cylinder times the number of cylinders

$(3.14)(2.3125 \text{ in})^2 (3.5 \text{ in}) = 58.77 \text{ cu in/cylinder}$

$(58.77 \text{ cu in/}\cancel{\text{cylinder}})(6 \cancel{\text{cylinders}}) = 352.62 \text{ cu in}$

12. Volume of one cylinder times the number of cylinders

$(3.14)(2.3125 \text{ in})^2 (3.5 \text{ in}) = 58.77 \text{ cu in/cylinder}$

$(58.77 \text{ cu in/}\cancel{\text{cylinder}})(8 \cancel{\text{cylinders}}) = 470.16 \text{ cu in}$

13. Volume of one cylinder times the number of cylinders

$(3.14)(2.0625 \text{ in})^2 (5 \text{ in}) = 66.79 \text{ cu in/cylinder}$

$(66.79 \text{ cu in/}\cancel{\text{cylinder}})(6 \cancel{\text{cylinders}}) = 400.72 \text{ cu in}$

14. Volume of one cylinder times the number of cylinders

$(3.14)(2.21875 \text{ in})^2 (5 \text{ in}) = 77.29 \text{ cu in/cylinder}$

$(77.29 \text{ cu in/cylinder})(6 \text{ cylinders}) = 463.73 \text{ cu in}$

A. Problems with solutions.

1. The capacitance of an air-dielectric, parallel-plate capacitor is given by:

$$C = 0.225 \frac{(n-1)\ A}{t}$$

where C is capacitance in micromicrofarads ($10^{-12}$); n = number of plates; A = area of one side of one plate in inches and t = separation of the plates in inches.

You have acquired a variable air-dielectric capacitor and wish to determine its maximum capacitance. The unit has 10 plates and measurement shows a plate separation of 0.1 inches. Each plate is configured according to the diagram below:

Calculate the maximum capacitance which the unit would have with the plates closed, i.e. with the plate surfaces parallel to each other.

Solution: Complete plate area for the quarter circle:

$$\text{Area}_1 = \frac{(\pi)\ (r^2)}{4} = \frac{(\pi)\ (2.1\text{ in.})^2}{4} = 3.46 \text{ sq in}$$

compute plate area for the triangle:

$$\text{Area}_2 = 1/2\ bh = (1/2)(3.5\text{ in} - 2.1\text{ in})(2.1\text{ in}) = 1.47 \text{ sq. in.}$$

Compute area of one plate:

$$\text{Area}_T = \text{Area}_1 + \text{Area}_2 = 3.46 \text{ sq in} + 1.47 \text{ sq in} = 4.93 \text{ sq in}$$

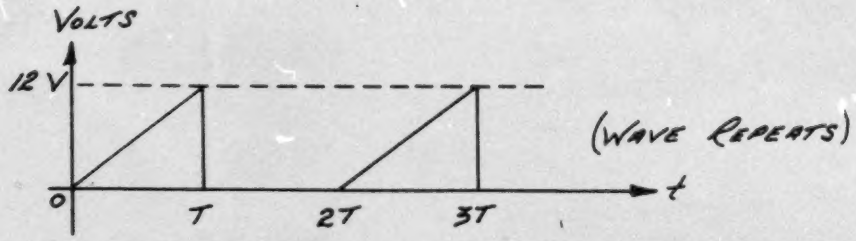
Calculate C max.

$$C = (0.225)\left(\frac{(10 - 1)(4.93)}{0.1}\right)$$

$$= 99.8 \text{ micromicrofarads}$$

B. Problems without solutions.

2.




The "sawtooth" wave above is commonly used to generate a linear movement of an electron beam in cathode ray tube devices. It becomes necessary in circuit measurements to determine the average voltage and/or current of such waves.

If the repeating waveform above were displayed on an oscilloscope, determine the average voltage which it would represent over any period of time.

3. Electrical conductors have a resistance to current flow which varies inversely as the cross-sectional area and directly as the length of the conductor. The unit of area used is unique to electrical applications and is called the circular mil. One circular mil is the area of a conductor which is 1 mil (0.001") in diameter. The area of any conductor in circular mils (CM) is its diameter (in mils) squared;

$$A_{CM} = (\text{d mils})^2$$

Copper wire tables give the resistivity, p, of wires in OHMs per circular-mil-foot. Thus, for any diameter or length, $R = p\frac{L}{d^2}$

where: R = OHMs; P = resistivity in OHMs/CM ft; d = diameter of the conductor in mils and L = length of conductor in feet.

a. Compare the area of 1 CM to 1 square mil by converting both to square inches.

b. AWG #10 solid, hard drawn copper wire has a diameter of 0.102" and a resistivity, p, of 10.7 OHMs /circular-mil-foot. Find the resistance of 1000 feet of this wire.

AREA
Level II

Complete solutions to B problems.

2. Find the area of one cycle, t = 0 to t = T

$$\text{Area}_1 = 1/2\ bh = \frac{12T \text{ volts}}{2}$$

Find the area of the period t = T to t = 2T

$$\text{Area}_2 = 1/2\ bh = (1/2)(0)(0) = 0$$

The average voltage is then the average from t = 0 to t = 2T since the wave repeats.

$$V_{avg} = (\text{Area}_1 + \text{Area}_2)\left(\frac{1}{2T}\right) = \left(\frac{12T \text{ volts}}{2} + 0\right)\left(\frac{1}{2T}\right) = \frac{12T\text{volts}}{4T}$$

$$= 3 \text{ volts}$$

3. a) For a circular conductor,

$$A = \frac{\pi d^2}{4}$$

$$A_{CM} = (\pi)\left(\frac{(0.001 \text{ in})}{4}\right) = 7.85 \times 10^{-7} \text{sq in}$$

For a square conductor,

$$A = (L)(W) = (0.001 \text{ in})\ (0.001 \text{ in}) = (10)(10^{-7} \text{ sq in})$$

$$\frac{CM}{\text{sq. mil}} = \frac{(7.854)(10^{-7} \text{ sq in})}{(10)(10^{-7} \text{ sq in})} = 0.7854 \text{ or sq mils} =$$

$$= (CM)(0.7854 \text{ sq in})$$

b) $$R = P\frac{L}{d^2} = \left(10.7 \frac{\text{OHMs}}{\text{CM-}\cancel{\text{ft}}}\right)\left(\frac{1000\ \cancel{\text{ft}}}{(102\text{mil})^2}\right) = 1.028 \text{ OHMs}$$

A. Problems with solutions.

1. The following problems are encountered in an erosion control plan following a lumber harvest. Determine the number of acres which will need reseeding in each of parts a, b, and c and then determine the total acreage to be reseeded. (use 5280ft = 1 mile and 43560 sq.ft = 1 acre).

a) 86 landings will need reseeding. They average .1 acre in size.

b) There are 6.5 miles of temporary spur road on the sale area that will be disturbed and needs reseeding. The roads are 12 ft wide.

c) The operator will have approximately 3 skid trails for each of the 86 landings which will need reseeding. They will average 400 ft in length and 12 feet in width.

Solution:

a) $(86\ \cancel{\text{landings}})\left(\frac{0.1\ \text{acre}}{\cancel{\text{Landing}}}\right) = 8.6\ \text{acres}$

b) $(6.5\ \cancel{\text{miles}})\left(5280\ \frac{\text{ft}}{\cancel{\text{mile}}}\right) = 34{,}320\ \text{ft}$

c) (length) (width)

$= (34{,}320\text{ft})(12\text{ft})$

$= 411{,}840\ \text{sq ft}$

Converting

$(411{,}840\ \cancel{\text{sq ft}})\left(\frac{1\ \text{acre}}{43560\ \cancel{\text{sq ft}}}\right) = 9.45\ \text{acres}$

c) $(86\ \cancel{\text{landings}})(3\ \frac{\text{skids}}{\cancel{\text{landing}}}) = 258\ \text{skids}$

area of a skid is:

(length) (width)

$= (400\text{ft})\ \ (12\text{ft})$

$= (4800\ \frac{\text{sq ft}}{\cancel{\text{skids}}})\ (258\ \cancel{\text{skids}}) = 1{,}238{,}400\ \text{sq ft.}$

$\frac{1{,}238{,}400\ \cancel{\text{sq ft}}}{43{,}560\ \cancel{\text{sq ft}}/\ \text{acre}} = 28.43\ \text{acres}$

Total acres = 8.6 acres + 9.45 acres + 28.43 acres = 46.48 acres.

A. Problems with solutions, continued.

2. Three fourths of a section is to be seed spotted with pine at a 6x6 foot spacing (between the grown trees) with seed having 17,000 seeds/lb.

a) If a section is 640 acres what size area are we seeding?

b) Using 43560 sq ft in an acre how many seedlings/acre will be needed at the required spacing?

c) Experience has shown germination in the field of 50% of the seed but only 20% of the germinating seedlings survive at the end of the first growing season. At this rate how many seeds/acre will be required?

d) How many lbs of pine seed is required for seed spotting this area?

e) At $20/lb what will be the total cost for pine seed?

Solution:

a) $(640 \frac{\text{acres}}{\text{section}})$ (3/4 section) = 480 acres

b) 6x6 foot spacing is equivalent to one per 36 sq. ft

$$\left(\frac{43{,}560 \text{ sq ft}}{\text{acre}}\right) \left(\frac{1 \text{ seedling}}{36 \text{ sq ft}}\right) = 1210 \text{ seedlings/acre}$$

c) (.50)(.20) = .10 . So only 10% of the seed will result in a surviving seedling. Thus 10 seeds will be required for each of the seedlings.

$$\left(10 \frac{\text{seeds}}{\text{seedling}}\right)\left(1210 \frac{\text{seedlings}}{\text{acre}}\right) = 12{,}100 \frac{\text{seeds}}{\text{acre}}$$

d) $\left(\frac{12100 \text{ seeds}}{\text{acre}}\right) \left(\frac{1 \text{ lb}}{17000 \text{ seeds}}\right) (480 \text{ acres}) = 341.6 \text{ lbs}$

e) $\left(\frac{\$20}{\text{lb}}\right)$ (341.6 lbs) = $6832.

A. Problems with solutions.

3. In measuring trees, the most common methods are to express them in terms of DBH (diameter at breast height) or basal area, (area of cross section at breast height). Neither of these can be measured directly but can be calculated. The circumference, however, can be measured directly and then using formulas for a circle ($C=\pi d$) and $A=\pi r^2$ where $\pi = 3.1416$ the DBH and basal area can be determined.

Given the circumference measurement at breast height of 69.12 inches determine:

a) DBH
b) basal area (sq. in)
c) basal area (sq. ft)

Solution:

a) $C = (\pi)(d)$

$69.12 \text{ inches} = (3.1416)(d)$

$$d = \frac{69.12 \text{ inches}}{3.1416} = 22 \text{ inches}$$

b) $$r = \frac{d}{2} = \frac{22 \text{ inches}}{2} = 11 \text{ in.}$$

$A = 3.1416 (11 \text{ inches})^2 = 3.1416 (121 \text{ sq inches}) = 380.1 \text{ sq in.}$

c) $$(380.1 \text{ sq in}) \left(\frac{1 \text{ sq ft}}{144 \text{ sq in}}\right) = 2.64 \text{ sq ft.}$$

A. Problems with solutions.

4. For a stand of timber you have obtained the following information: in 1/5 acre plots the average stand diameter is 11.5 in with an average of 110 trees per plot. Calculate:

a) number of trees per acre

b) Basal area of an 11.5 in diameter tree(sq, in and sq rt).

c) Total basal area (sq.ft/acre)

d) If the management plan calls for thinning 25% of the basal area how much basal area/acre will be left after thinning?

Solution:

a) $\left(\frac{110 \text{ trees}}{\text{plot}}\right)\left(\frac{5 \text{ plots}}{\text{acre}}\right) = 550 \text{ trees/acre}$

b) using $A = \pi r^2$

$$A = (3.1416)\left(\frac{11.5 \text{ in}}{2}\right)^2 = 103.87 \text{ sq. in}$$

$$A = (103.87 \text{ sq. in})\left(\frac{1 \text{ sq ft}}{144 \text{ sq. in}}\right) = .7213 \text{ sq ft.}$$

c) $\left(\frac{.7213 \text{ sq ft}}{\text{tree}}\right)\left(\frac{550 \text{ trees}}{\text{acre}}\right) = 396.72 \text{ sq ft/acre}$

d) $\left(396.72 \frac{\text{sq.ft}}{\text{acre}}\right)\left(.75\right) = 297.54 \frac{\text{sq,ft}}{\text{acre}}$

B. Problems without solutions.

5. Of 800 acres of timber 40% have been clearcut. Half of the clear cut area is to be reseeded.

a) What is the total area to be reseeded (acres)?

b) If the seedlings are to be spaced 7ft by 7 ft how many seedlings will be needed per acre? (43560 sq ft = 1 acre).

c) What is the total number of seedlings needed?

d) If there are approximately 20,000 nursery seedlings per lb of seed and there is 1/2 lbs seed/bushel of cones, determine the number of bushels of cones that will have to be collected to reseed this area.

B. Problems without solutions.

6. 800 acres of timber was purchased of which 40% has been clearcut. Half of the clearcut area is to be aerially seeded with Douglas Fir at one lb of seed per acre.

a) What is the total area to be seeded?

b) What is the total amount of seed needed?

c) If seed costs $15/lb and the cost of aerial seeding is $4.50 acre, what is the total cost of seeding the acre?

d) If a helicopter (with two seed hoppers) flying at 50 mph can release 40.4 oz seed/hopper/minute, how long will it take to seed the area?

B. Problems without solutions.

7. Eighty per cent of a section is covered with Douglas Fir at a 9x9 foot spacing. Before planting the fir area is to be sprayed with atrazine (80% active) at the rate of 4 lbs of active ingredient per acre.

a) How many acres are in the Douglas Fir area? (1 section = 640 acres)

b) How many lbs of atrazine will be required to spray the area?

c) At $3/lb for atrazine and $4/acre for spraying, what is the total cost of spraying the area?

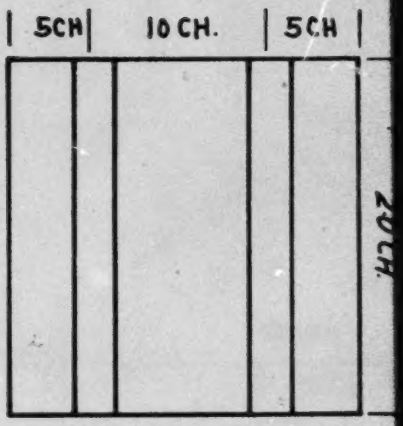
d) Determine the number of trees/acre at the required spacing. (1 acre = 43560 sq. ft).

e) at 20000 seedlings/lb of Douglas Fir seed, how many lbs of seed will be required?

B. Problems without solutions.

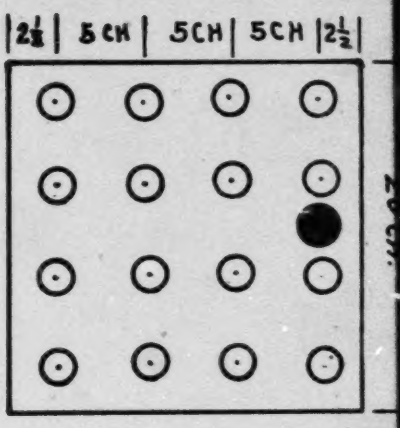
8. a) In the drawing(a), a timber cruiser has run two 1 chain wide strips across a "forty" (40 acres) and has measured all trees within the strip. How many sq. chains of timber has he measured? How many acres? How many sq. ft? What percentage of the total area of the "forty" has he cruised? ( 1 acre = 10 sq. chains)

(a)



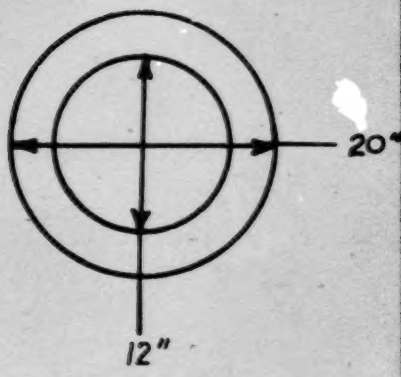

b) In the drawing (b) another cruiser has measured each tree within a 1/4 acre circular plot spaced as shown. How many acres of timber has he cruised? What percentage of the total area of the "forty" has he cruised?

(b)



B. Problems without solutions.

9. Consider the drawing at the right to be the cross section of a log 20" in diameter with the inner circle representing a diameter of 12".




a) Assume that the area between these two circles represents the sapwood of the log which is worm infested. What is the area of this sapwood and what per cent of the cross sectional area of the log does it represent?

b) Suppose the smaller circle represents the rotted center of a log and the sapwood is good. What is the area of this rotted center and what per cent of the cross sectional area of the log does it represent?

Complete solutions to B problems.

5. Solution:

a) (800 acres) (.40) $\left(\frac{1}{2}\right)$ = 160 acres

b) Being spaced 7 ft by 7ft is equivalent to one seedling per 49 sq ft thus:

$$\left(\frac{43560 \text{ sq. ft}}{\text{acre}}\right)\left(\frac{1 \text{ seedling}}{49 \text{ sq. ft}}\right) = 889 \text{ seedlings/acre or}$$

$$\frac{43560 \frac{\text{sq ft}}{\text{acre}}}{49 \text{ sq. ft/ seedling}} = 889 \frac{\text{seedlings}}{\text{acre}}$$

c) $\left(889 \frac{\text{seedlings}}{\text{acre}}\right)$ (160 acres) = 142,240 seedlings

d) (142,240 seedlings) $\left(\frac{1 \text{ lb seed}}{20000 \text{ seedlings}}\right)\left(\frac{1 \text{ bushel of cones}}{\frac{1}{2} \text{ lbs seed}}\right)$

= 14.224 bushels of cones

6. Solution:

a) (800 acres ) (.40) ( 1/2) = 160 acres

b) (160 acres) $\left(\frac{1 \text{ lb seed}}{\text{Acre}}\right)$ = 160 lbs seed.

c) $\left(\frac{15 \text{ dollars}}{\text{lb}}\right)$ ( 160 lb) + $\left(\frac{4.50 \text{ dollars}}{\text{acre}}\right)$ (160 acres) =

$2400 + $720 = $3120

d) $\left(\frac{40.4 \text{ oz seed/hopper}}{\text{minute}}\right)$ (2 hoppers) $\left(\frac{1 \text{ lb}}{16 \text{ oz}}\right)$ = 5.05 $\frac{\text{lbs seed}}{\text{minute}}$

(160 lbs seed) $\left(\frac{1 \text{ minute}}{5.05 \text{ lbs seed}}\right)$ = 31.68 minutes

Complete solutions to B problems.

7. Solution:

a) 640 acres (.80) = 512 acres

b) Since the chemical is 80% active ingredient, 4 lbs of active ingredient/acre is equivalent to 5 lbs atrazine/acre.

$$\left(\frac{5 \text{ lbs}}{\text{acre}}\right) (512 \text{ acres}) = 2560 \text{ lbs.}$$

c) ($3/~~lb~~) (2560 ~~lbs~~) + ($4/~~acre~~) (512 ~~acres~~) = $7680 + $2048 = $9728.

d) 9 by 9 ft spacing is equivalent to one tree per 81 sq ft.

$$\left(\frac{43560 \text{ ~~sq ft~~}}{\text{acre}}\right)\left(\frac{1 \text{ tree}}{81 \text{ sq ~~ft~~}}\right) = 538 \text{ trees/acre}$$

e) $\left(\frac{538 \text{ ~~trees~~}}{\text{~~acre~~}}\right)\left(\frac{1 \text{ lb.}}{20000 \text{ ~~trees~~}}\right)$ (512 ~~acres~~) = 13.8 lbs

*

8. Solutions:

a) (2) (1 chain) (20chain) = 40 sq chains.

$$(40 \text{ ~~sq ch~~})\left(\frac{1 \text{ acre}}{10 \text{ ~~sq ch~~}}\right) = 4 \text{ acres}$$

$$(4 \text{ acres})\left(\frac{43560 \text{ sq ft}}{\text{acre}}\right) = 174,240 \text{ sq ft.}$$

$$\frac{4 \text{ acres}}{40 \text{ acres}} = .10 = 10\%$$

b) (16 ~~plots~~) $\left(\frac{1}{4} \frac{\text{acre}}{\text{~~plot~~}}\right)$ = 4 acres

$$\frac{4 \text{ ac}}{40 \text{ ac}} = .10 = 10\%$$

Complete solutions to B problems.

9. Solutions:

a) Area of larger circle $= \pi r^2 = (3.1416)\left(\frac{20 \text{ inches}}{2}\right)^2 = 314.16$ sq in.

Area of smaller circle $= (3.1416)\left(\frac{12\text{in}}{2}\right)^2 = 113.10$ sq in.

Area of sapwood = 314.16 sq in - 113.10 sq in = 201.06 sq in.

(314.16 sq in)( r) = 201.06 sq in.

$$r = \frac{201.06 \text{ sq in}}{314.16 \text{ sq in}} = .64 = 64\% \text{ of log.}$$

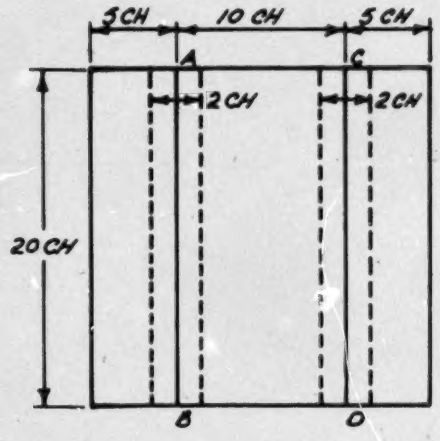
b) From part (a) area of rotted center is 113.10 sq in.

(314.16 sq in)(r) = 113.10 sq in.

$$r = \frac{113.10 \text{ sq in}}{314.16 \text{ sq in.}} = .36 = 36\% \text{ of log.}$$

A. Problems with Solutions

1. If a timber cruiser ran two parallel lines AB and CD across a forty (see sketch below) and tallied all trees for one chain on each side of each line -
   a) How many acres of timber would he tally?
   b) By what number would he multiply the answer in a) to obtain an estimate of the total number of trees in the forty acres?




Solution:

$$\text{Total area tallied} = (2)(2 \text{ ch})(20 \text{ ch})$$
$$= 80 \text{ sq ch}$$
$$= 8 \text{ acres}$$

$$\frac{\text{Acres tallied}}{\text{Total acres}} = \frac{\text{Tally}}{\text{Total estimate}}$$

$$\text{Total estimate} = \frac{(\text{Tally})(40 \text{ acres})}{8 \text{ acres}} = (5)(\text{Tally})$$

B. Problems without Solutions

2. Determine how much larger, in percent, an area 14 miles square is as compared to an area of 14 square miles.

B. Problems without Solutions (continued)

3. A rectangular piece of land 4.7 chains by 16.2 chains contains how many square chains -- how many acres?

4. Determine the radius and circumference of a 1/5 acre plot.

5. Determine the perimeter in chains and area in acres of a fire which occupies (completely) a region in the shape of a right triangle located in the southwestern half of a quarter section. (There are 80 chains per mile, 10 sq chains per acre.)

B. Problems without Solutions (continued)

6. Determine the largest square timber which can be cut from a 24 foot log whose small end diameter is 20 inches.

Level 1

Complete Solutions to B Problems

2. An area 14 miles square contains

(14 miles)(14 miles) = 196 sq mi

Percentage difference between 196 sq mi and 14 sq mi

$$\text{Percent} = \left(\frac{196 \text{ sq mi}}{14 \text{ sq mi}}\right)(100) = 1400\%$$

3. Area in square chains = (4.7 chains)(16.2 chains)

= 76.1 sq ch

$$\text{Area in acres} = \frac{\text{area in sq ch}}{\text{sq ch/acre}} = \frac{76.1 \text{ sq ch}}{10 \text{ sq ch/acre}} = 7.61 \text{ acres}$$

4. 1/5 acre = (1/5)(43,560 sq ft) = 8,712 sq ft

$1/5 \text{ acre} = \pi r^2$

$$r = \sqrt{\frac{8{,}712 \text{ sq ft}}{3.14}} = 52.66 \text{ ft}$$

$C = 2\pi r$

$= 2(3.14)(52.66 \text{ ft}) = 330.87 \text{ ft}$

5. Length of each leg of the triangle is 1/2 mile

1/2 mile = 40 chains

Length of the hypotenuse = $(\sqrt{2})$(1/2 mile)

= 0.707 miles

convert to chains $= \frac{0.707 \text{ mi}}{80 \text{ ch/mi}}$

= 56.56 chains

Perimeter = 40 chains + 40 chains + 56.56 chains = 136.56 chains

Area of triangle = (1/2)(base)(height)

= (1/2)(40 ch)(40 ch)

= 800 sq ch

= 80 acres

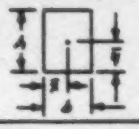
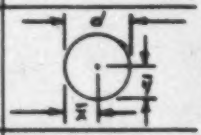
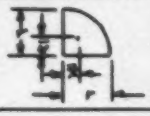
6. By the Pythagorean Theorem, the length of a side of a square whose diagonal is D is $D/\sqrt{2}$.

Therefore, the dimensions of the timber would be

$\frac{20}{\sqrt{2}}$ inches or 14.14 inches

A. Problems with Solutions

The centroids of common geometric figures are shown in the following table:

| Shape | Area | $\bar{x}$ | $\bar{y}$ | |
|---|---|---|---|---|
| Rectangle | $bh$ | $\frac{b}{2}$ | $\frac{h}{2}$ |  |
| Triangle | $\frac{bh}{2}$ | $\frac{b}{3}$ | $\frac{h}{3}$ | |
| Circle | $\frac{\pi d^2}{4}$ | $\frac{d}{2}$ | $\frac{d}{2}$ |  |
| Semicircle | $\frac{\pi d^2}{8}$ | $\frac{d}{2}$ | $\frac{4r}{3\pi}$ $(.424r)$ | |
| Quadrant | $\frac{\pi r^2}{16}$ | $.425r$ | $.425r$ |  |

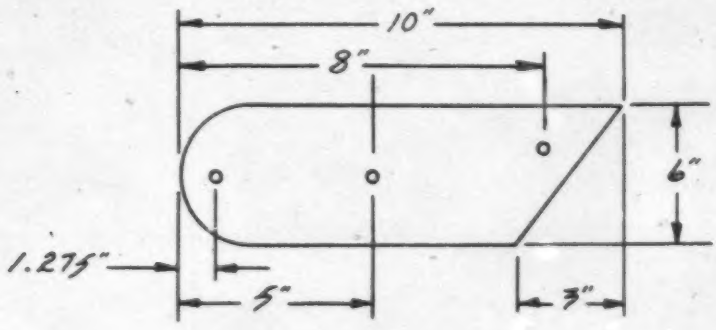
When computing the centroid of a complex figure one simply divides the figure into a number of these common forms. He then uses the following relationship to tabulate $\bar{Y}$ and $\bar{X}$.

$$(A_1 + A_2 + \ldots + A_n)\ \bar{Y} = A_1Y_1 + A_2Y_2 + \ldots + A_nY_n$$

also

$$(A_1 + A_2 + \ldots + A_n)\ \bar{X} = A_1X_1 + A_2X_2 + \ldots + A_nX_n$$

1. Locate the centroid of the piece of sheet metal shown below:



A. Problems with Solutions (continued)

1. Solution:

Divide this complex figure into a semicircle, a rectangle and a triangle.

Area of semicircle = $A_1 = \frac{(\pi)(6\text{ in})^2}{8} = 14.13$ sq in

Area of rectangle = $A_2 = bh = (4\text{ in})(6\text{ in}) = 24$ sq in

Area of the triangle = $A_3 = \frac{bh}{2} = \frac{(3\text{ in})(6\text{ in})}{2} = 9$ sq in

Total area = $\sum A = 47.13$ sq in

$$\bar{X} = \frac{A_1X_1 + A_2X_2 + A_3X_3}{\sum A}$$

$$= \frac{(14.13\text{ sq in})(4r/2\pi) + (24\text{ sq in})(3 + b/2) + (9\text{ sq in})(7 + b/3)}{47.13\text{ sq in}}$$

$$= \frac{(14.13\text{ sq in})(1.275\text{ in}) + (24\text{ sq in})(5\text{ in}) + (9\text{ sq in})(8\text{ in})}{47.13\text{ sq in}}$$

$$= \frac{210.06\ \cancel{\text{cu}}\ \text{in}}{47.13\ \text{sq}\ \cancel{\text{in}}}$$

$$= 4.46\text{ in}$$

$$\bar{Y} = \frac{A_1Y_1 + A_2Y_2 + A_3Y_3}{\sum A}$$

$$= \frac{(14.13\text{ sq in})(d/2) + (24\text{ sq in})(h/2) + (9\text{ sq in})(6 - h/3)}{47.13\text{ sq in}}$$

$$= \frac{(14.13\text{ sq in})(3\text{ in}) + (24\text{ sq in})(3\text{ in}) + (9\text{ sq in})(4\text{ in})}{47.13\text{ sq in}}$$

$$= \frac{150.39\ \cancel{\text{cu}}\ \text{in}}{47.13\ \text{sq}\ \cancel{\text{in}}}$$

$$= 3.19\text{ in}$$

A. Problems with Solutions (continued)

Tension -- A tensil force is a pulling force that tends to lengthen the body it acts on in the direction of the pull. (lb/sq in)

Compression -- A compressive force is one that pushes or presses on a body and tends to shorten it in the direction of the force. (lb/sq in)

Shear -- A shearing force results when two equal parallel forces act in opposite direction on a body. (F = lbs/area)

Stress(axial) -- Stress are equally distributed over the cross section of the structure.

2. Determine the size of a short square post of Douglas Fir, structural grade, necessary to sustain an axial load of 42,000 lb.
Note: From Wook Handbook Forest Product, the allowable compressive stress equals 1400 lb/sq in.

Solution:

To determine the required size, divide the axial load by the maximum allowable compressive stress.

$$\text{Cross-sectional area} = \frac{42{,}000 \text{ lbs}}{1400 \text{ lbs/sq in}} = 30 \text{ sq in}$$

So the post must be 5 1/2 inches square so use a 6" x 6"

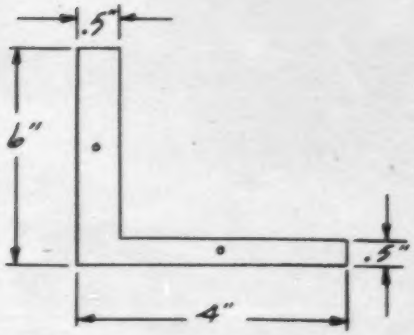
B. Problems without Solutions

3. A 6" x 6" x 3/4" angle iron has a cross-sectional area of 8.44 sq in. If the angle is subjected to a tensile load of 131,000

is 20,000 lb/sq in is the angle iron the safe size for this load?

B. Problems without Solutions (continued)

4. Locate the centroid of the cross-section of an angle 6" x 4" x 1/2".




5. Two rivets are used at the end of a truss; the total stress in the member is 18,400 lb. What should be their diameter if the shearing unit stress is 13,500 lb/sq in?

B. Problems without Solutions (continued)

6. What load may be placed on a short timber post whose dimensions are 12" x 18", if the allowable compressive stress is 1180 lb/sq in?

7. The allowable bearing value of a foundation is 3 tons/sq ft. What sould be the length of a side of a square footing if the load on the column and footing is 329 kips?
Note: 1 kips = 1000 lbs dead weight

8. Two steel bars in a truss are riveted together with 1/2 inch diameter rivets. The total stress on the bars is 15,000 lb. Consider only shear, how many rivets should be used. Allowable shearing unit stress is 13,500 lb/sq in.

Complete solutions to B Problems

3. Tensile unit stress = $\frac{\text{load}}{\text{cross-sectional area}}$

$$= \frac{131{,}000 \text{ lbs}}{8.44 \text{ sq in}}$$

$$= 15{,}520 \text{ lbs/sq in}$$

If the unit stress allowable is 20,000 lbs/sq in, the iron is safe.

4. The area of the base rectangle is

$$A = bh = (4 \text{ in})(0.5 \text{ in}) = 2 \text{ sq in}$$

The area of the side rectangle is

$$A = bh = (6 \text{ in} - 0.5 \text{ in})(0.5 \text{ in}) = 2.75 \text{ sq in}$$

Total area = A = 4.75 sq in

$$\bar{X} = \frac{A_1X_1 + A_2X_2}{\sum A} = \frac{(2 \text{ sq in})(b/2) + (2.75 \text{ sq in})(b/2)}{4.75 \text{ sq in}}$$

$$= \frac{(2 \text{ sq in})(2 \text{ in}) + (2.75 \text{ sq in})(0.25 \text{ in})}{4.75 \text{ sq in}}$$

$$= 0.99 \text{ in}$$

$$\bar{Y} = \frac{A_1Y_1 + A_2Y_2}{\sum A} = \frac{(2 \text{ sq in})(h/2) + (2.75 \text{ sq in})(h/2)}{4.75 \text{ sq in}}$$

$$= \frac{(2 \text{ sq in})(0.25 \text{ in}) + (2.75 \text{ sq in})(2.75 \text{ in})}{4.75 \text{ sq in}}$$

$$= \frac{0.5 \text{ cu in} + 7.56 \text{ cu in}}{4.75 \text{ sq in}}$$

$$= 1.70 \text{ in}$$

5. The total stress is 18,400 lbs. Therefore, the stress on each rivet is 9,200 lbs. If these rivets can stand a stress of 13,500 lbs/sq in, their cross-sectional area must be

$$\frac{9{,}200 \text{ lbs}}{13{,}500 \text{ lbs/sq in}} = 0.68 \text{ sq in}$$

Cross-sectional area = $\frac{\pi D^2}{4}$ = 0.68 sq in

Solving for D $\pi D^2 = 2.73$ sq in

$D^2 = 0.87$ sq in

$D = 0.93$ in

Complete soltuions to B Problems (continued)

6. The cross-sectional area of this timber is

$$(12 \text{ in})(18 \text{ in}) = 216 \text{ sq in}$$

If the allowable compressive stress is 1180 lbs/sq in then this timber could support

$$(1180 \text{ lbs/}\cancel{\text{sq in}})(216 \cancel{\text{sq in}}) = 254{,}880 \text{ lbs}$$

7. The load on the column and footing is 329 kips which is

$$(329 \cancel{\text{kips}})(1/2 \text{ ton/}\cancel{\text{kip}}) = 164.5 \text{ tons}$$

If the bear value is 3 tons/sq ft, the footing must be

$$\frac{164.5 \cancel{\text{tons}}}{3 \cancel{\text{tons}}/\text{sq ft}} = 54.83 \text{ sq ft}$$

in area. This means it must be 7.4 ft on a side.

8. Total stress is 15,000 lbs. If the rivets can withstand 13,500 lbs/sq in, you require

$$\frac{15{,}000 \cancel{\text{lbs}}}{13{,}500 \cancel{\text{lbs}}/\text{sq in}} = 1.11 \text{ sq in}$$

of cross-section. Since the area of one rivet is

$$(\pi)(r^2) = (\pi)(0.5 \text{ in})^2 = (\pi)(0.25 \text{ sq in}) = 0.79 \text{ sq in}$$

you need

$$\frac{1.11 \cancel{\text{sq in}}}{0.79 \cancel{\text{sq in}}/\text{rivet}} = 1.41 \text{ rivets} \quad \text{so 2 rivets}$$